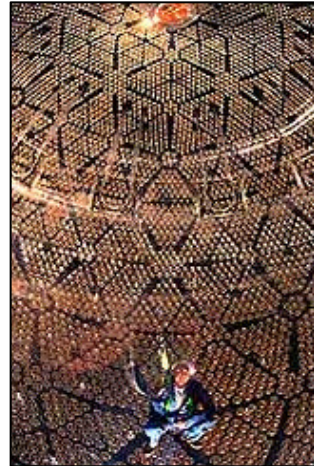
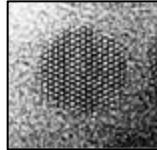
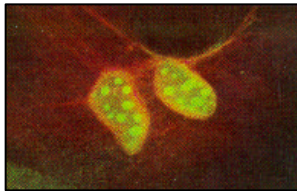
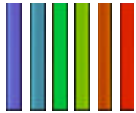
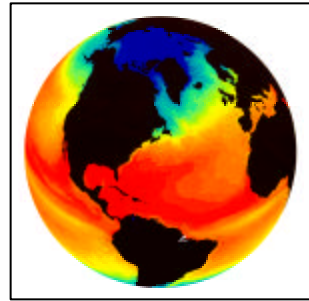
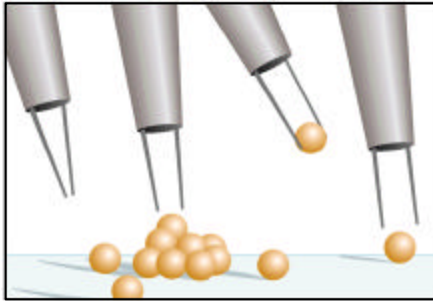




Strength Through Science



The FY 2001 Office of Science Budget Request

Science for America's Future

Office of Science FY 2001 Budget

- Provides significant growth for DOE Science programs in areas of strength and excellence
- Emphasizes new opportunities in the physical and life sciences and the interdependence between them
- Emphasizes new approaches in advanced scientific computing
- Delivers new capabilities and increased utilization for SC scientific user facilities
- Continues construction of the Spallation Neutron Source and the Large Hadron Collider

Office of Science Results & Recognition



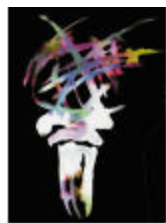
Breakthrough of the Year: First Runner-Up: *Genomics Speeds Ahead.*

In December 1998, the publication of the first genome of a multicellular organism, the nematode *Caenorhabditis elegans*, ushered in a new era in genomics--that of rapidly comparing thousands of genes in complex organisms. This year every facet of genomic technology accelerated, from sequencing to database management. As a result, genomics swept through biology, as researchers compared the sequences as well as the expression patterns of many thousands of genes at once.

Runners Up:

Rally for ribosomes: After a prolonged drum roll, the curtain came up this year on the structure of one of the cell's most important players, the ribosome. This massive protein-RNA complex produces proteins, somehow accurately translating genomic information into each of the tens of thousands of molecules needed for life. Structural biologists had struggled for decades to probe the complex molecular machine but were thwarted until recently by an intricate tangle of 54 proteins and three RNA strands

Flat and happy: Cosmologists can hardly believe their luck has changed. New observations often send them back to their equations, but this year, measurements of the cosmos's most basic numbers gave the answer they sought. The universe appears to contain just the amount of matter that the most elegant picture of its origins requires



Smithsonian 21st Century Pioneer Award Goes to Human Genome Program Leaders

DOE Science Dominates Supercomputing Awards

At SuperComputing '98, sponsored by the annual conference on high performance networking and computing, those who have pushed the envelope constantly stretching discipline were honored by the International Association of Supercomputing for their contributions. SC98 is sponsored by the International Association of Supercomputing for their contributions.

Teams supported by the Office of Science received a majority of the awards -- including both 1998 Gordon Bell Prizes, the 1998 Fernbach Award, and several

October 4, 1999

Asthma-linked Genes Identified

Researchers at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (LBNL) have announced the discovery of two genes that contribute to the development of asthma.

More than 14 million people in the United States suffer from asthma and other chronic respiratory ailments. The number of victims has doubled

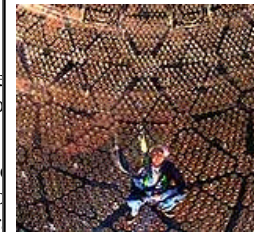
Science

The New York Times

June 22, 1999

Physicists Zero In on Ghostly Neutrinos

By MALCOLM W. BROWNE



Scientists operating huge underground detectors in Japan and Canada are racing to obtain independent proofs that the elusive neutrino, a ghostly particle whose vast family may constitute a large part of the mass of the universe, changes form as it flies through matter or space.

At least some neutrinos are now believed to have some mass, and physicists would love to learn how much, a goal that may be reached by studying the changes in form a traveling neutrino undergoes.

At issue is the effect of neutrinos, which pervade every cubic inch of the universe, on the rate at which the universe expands.

NATIONAL
Science

June 8, 1999

The New York Times
ON THE WEB

Systems Designed to Hold a Homemade Sun

By MALCOLM W. BROWNE

Scientists have developed a variety of devices and systems in which they hope to be able to compress hydrogen to the densities and temperatures needed to sustain thermonuclear fusion reactions. These are among them.

Tokamaks, reactors that are shaped like doughnuts and occupy large buildings, are chambers from which air has been removed and into which is injected a diffuse plasma of hydrogen isotopes, especially mixtures of deuterium and tritium. The plasma, a hot, electrically charged gas, is compressed within the doughnut by two sets of

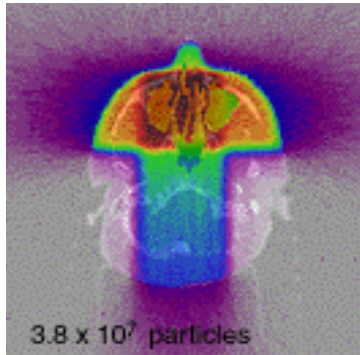
The computer-generated shapes on the cover are the unique antenna patterns created when light is scattered from an electron that undergoes a figure-of-eight orbit in the combined electronic and magnetic fields of a strong laser focus. Although predicted theoretically many decades ago, this phenomenon, a result of relativistic or nonlinear Thomson scattering, has only now been observed experimentally. Classical Thomson scattering is the scattering of low-intensity light by electrons, a process that leaves the frequency of radiation unchanged. In the relativistic variant, photons are radiated at various harmonics of the incident light frequency.



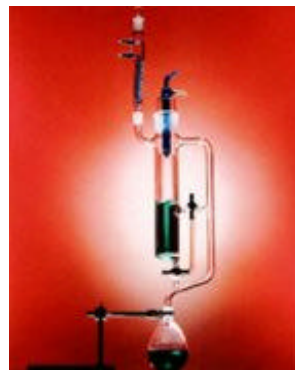
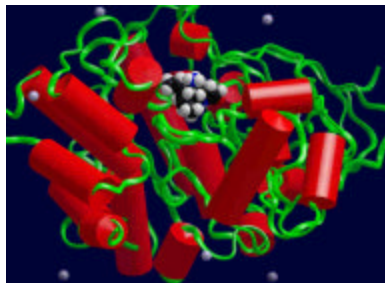
DOE Labs Win the Most R&D 100 Awards



100
R&D
AWARDS



1999



- DOE funded 43 of the 1999 R&D 100 Awards
 - DOE has won 529 R&D 100 Awards
 - DOE is the largest single winner both in '99 and historically
 - SC research won 11 of 43 awards this year including those pictured

Department of Energy Science

Top Five Government Research Organizations for*:

Physical Sciences	Environmental Sciences	Mathematics & Computing	Engineering	R&D Facilities**
1. Energy (2,012)	1. NASA (1,051)	1. DOD (657)	1. DOD (1,837)	1. Energy (939)
2. NASA (1,019)	2. NSF (481)	2. Energy (623)	2. NASA (1,948)	2. NASA (403)
3. NSF (515)	3. DOD (383)	3. NSF (399)	3. Energy (851)	3. DOD (386)
4. DOD (412)	4. INTERIOR (364)	4. HHS (127)	4. NSF (484)	4. NSF (271)
5. HHS (205)	5. Energy (335)	5. COMMERCE (89)	5. TRANS (323)	5. HHS (227)

* Numbers are FY 1999 Dollars in Millions - Source: NSF

** Numbers are FY 1999 Dollars in Millions - Source: OMB

U.S. Department of Energy

FY 2001 Congressional Budget Request

(Dollars in Millions)

Office of Science

<i>Program</i>	<i>FY 2000 Comparable Approp.</i>	<i>FY 2001 Request</i>	<i>Change</i>
Basic Energy Sciences	\$ 779.4	\$ 1,015.8	\$ +236.4 (30%)
Biological & Environmental Res.	434.1	445.3	+11.2 (3%)
Fusion Energy Science	247.8	247.3	-0.5 (0%)
Advanced Scientific Comp. Res.	127.9	182.0	+54.1 (42%)
High Energy Physics	703.8	714.7	+10.9 (2%)
Nuclear Physics	355.8	369.9	+14.1 (4%)
MELFS and ERA	34.1	34.9	+0.8 (2%)
Science Program Direction	131.7	141.2	+9.5 (7%)
Total	\$2,814.6	\$3,151.1	\$+336.5 (12%)
Technical Information Management	8.6	9.3	+0.7 (8%)

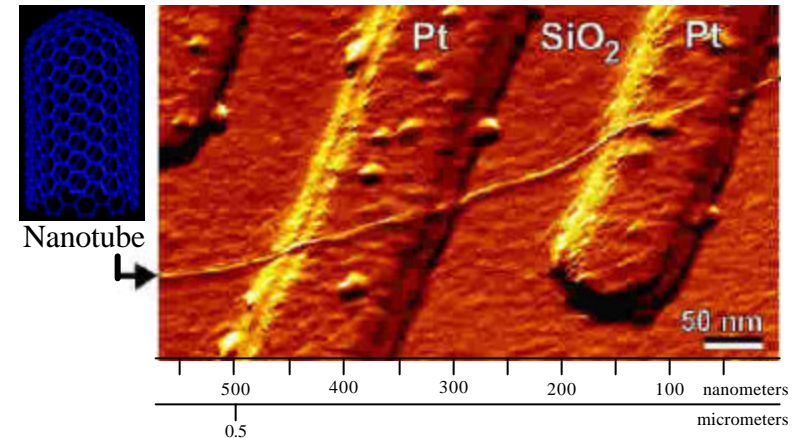
- Nanoscale Science, Engineering, and Technology (\$84M, +36M)
- High-Performance Computing for Science in the 21st Century -- Enhanced Capabilities (\$190M, +70M)
- Life Sciences -- Understanding the Microbial Cell (\$12M, +12M) and Biomedical Engineering (\$7M, +5M)
- Human (\$90M, +1M) & Microbial Genomes (\$22M, +8M)
- Global Climate Research (\$123M, +3M)
- Carbon Management Science (\$36M, +4M)
- Robotics & Intelligent Machines (\$3M, +2M)
- Spallation Neutron Source (\$281M, +163M)
- Scientific User Facilities Upgrades & Increased Utilization (\$1,207M, +65M)
- Large Hadron Collider (\$70M, +0)

numbers are FY01 request & increment from FY00 comparable appropriation

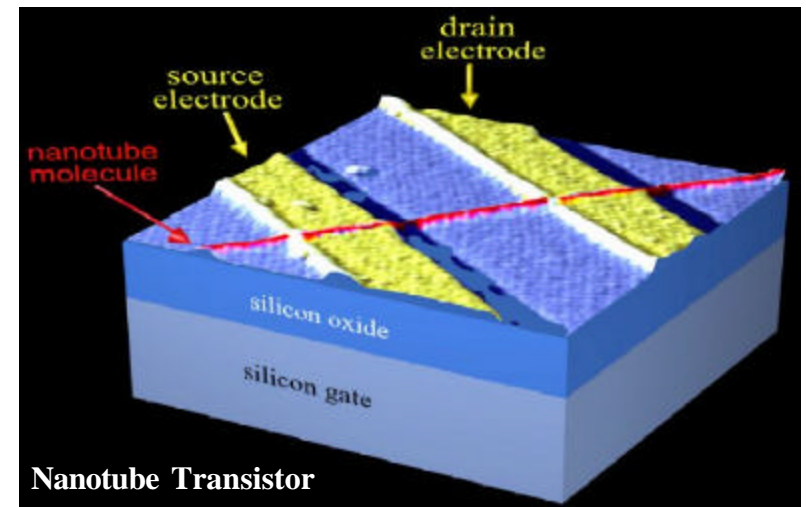
Nanoscale Science, Engineering, and Technology

Building Structures One Atom at a Time

- Tailor materials at the nanoscale for desired structure/function properties
 - *Materials with enhanced physical, mechanical, optical, electrical, tribological, or catalytic properties*
 - *Materials with the ability to self assemble, self repair, sense and respond to the environment*
- Long-term, high-risk, interagency activity -- a unique instance of common scientific and technological frontiers
- Combines expertise in materials sciences, chemistry, physics, biology, engineering, and computation
- Expected are technological developments to rival the impact of the transistor

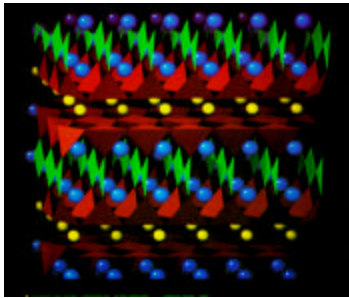


Nanotubes exhibit unique quantum-wire properties which derive from their nanometer diameter and the special electronic structure of graphite. Nanotube transistors have recently been fabricated. These three-terminal devices consist of an individual semiconducting nanotube on two metal nanoelectrodes with the substrate as a gate electrode.

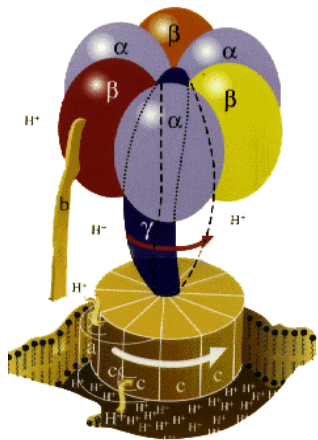


Nanoscale Science, Engineering, and Technology

The Challenges



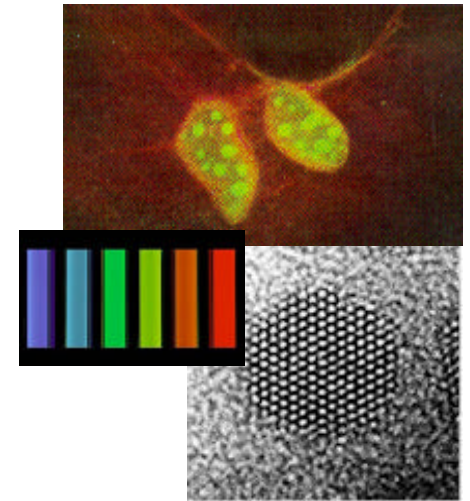
Superconductivity, a collective effect, enables materials to conduct electricity without loss.



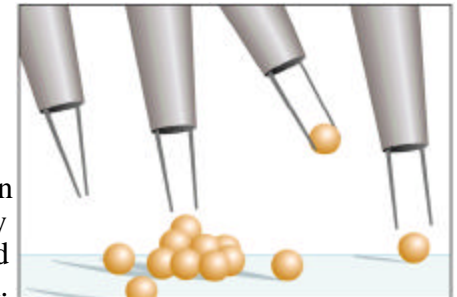
Enzymatic mechanism of ATP synthesis, a molecular rotator that can be incorporated into manmade structures

- Attain a fundamental understanding of nanoscale phenomena, particularly collective phenomena
- Design and synthesize materials at the atomic level to produce materials with desired properties and functions
- Understand the processes by which living organisms create materials and functional complexes to serve as a guide and benchmark for synthesis
- Create experimental tools and theory/modeling/simulation tools to drive the nanoscale revolution

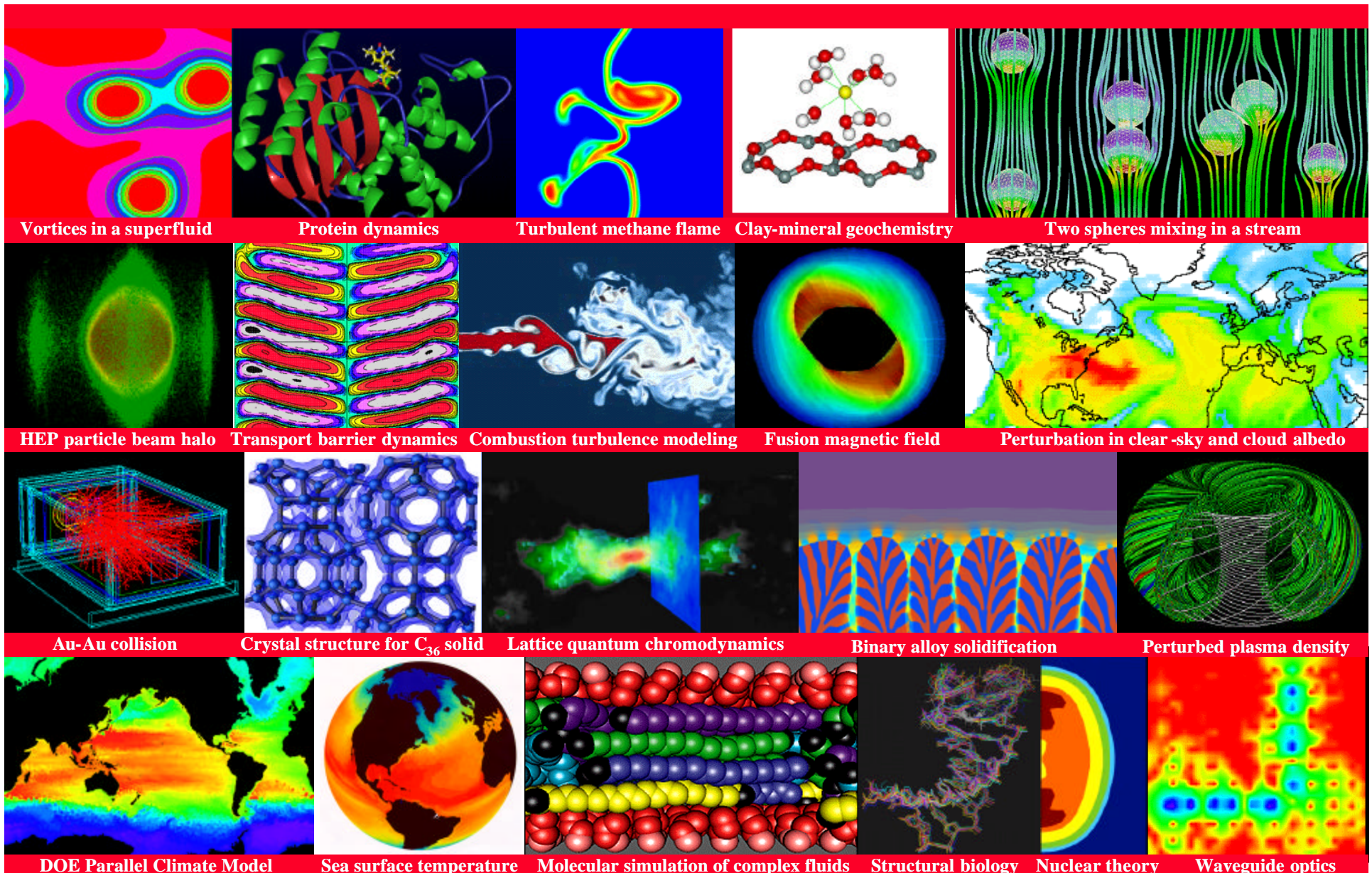
Cadmium selenide nanocrystals linked to biomolecules light up a cell's actin filaments (red) and nucleus (green).



Tweezers composed of carbon nanotubes grab a particle only about 500 nm in diameter and move it to a desired location.



Dramatic Increases in High-Performance Computing Required for 21st Century Scientific Leadership



Taking the Next Steps

Advanced Computational Modeling & Simulation

Tomorrow's computers will be:

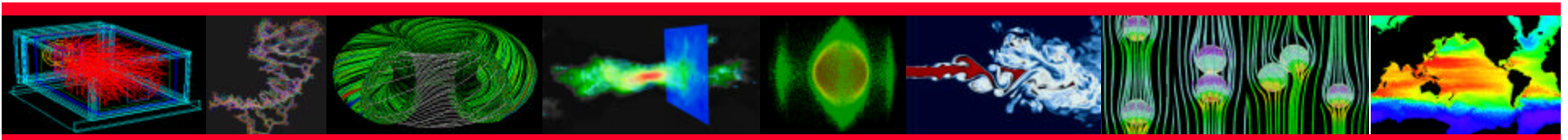
- **Fast** (*100 teraflops*)
- **Big** (*10,000 individual processors*)
- **Difficult to program** (*Requires a team approach*)
- **Massive data producers** (*Petabytes to view, move, and store*)

This requires:

- A new generation of modeling and simulation software
- Tools to make terascale computers useful for real-world problems
- A computing and network infrastructure - to provide terascale computer resources to the scientists that need them



Today's supercomputers are one teraflop machines with about 1,000 individual processors. Today's PCs store about 1 gigabyte of data, a petabyte is one million gigabytes.



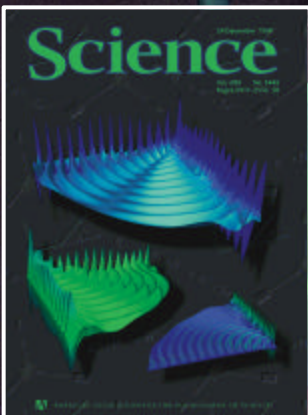
Advanced Scientific Computing Research (ASCR) Enables Scientific Computing in SC Programs

ASCR:

- *Develops mathematical, computing, networking, and visualization tools*
- *Develops and pilots national collaboratories*
- *Partners with SC Programs to promote and support computing for fundamental science*

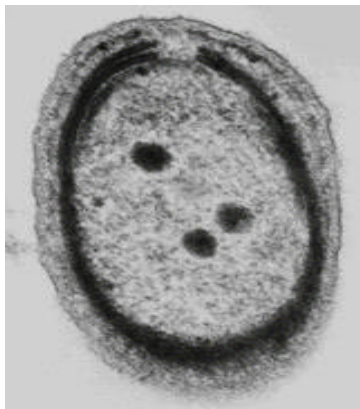
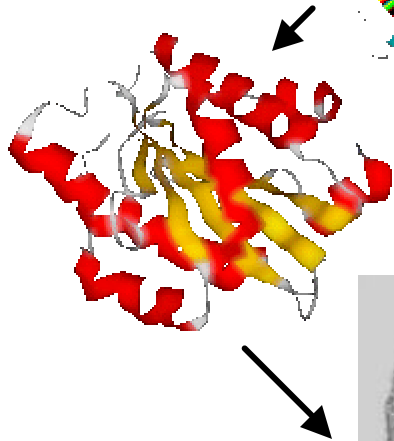
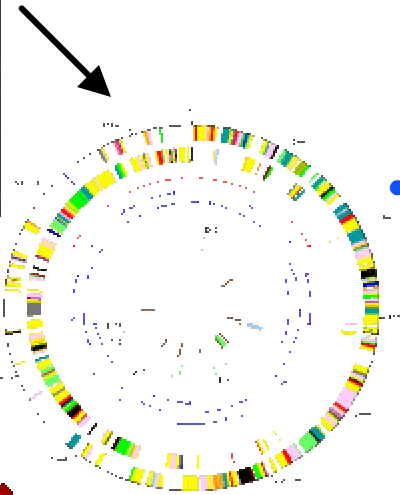
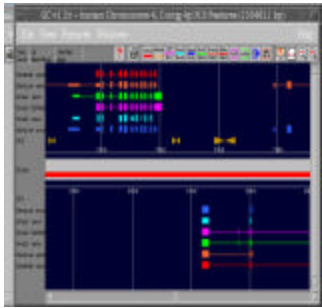
ASCR's accomplishments have revolutionized large scale computing:

- Developed national computing and networking facilities
- Provided the first interactive access to supercomputers
- Defined video teleconferencing standards
- Developed the most widely used parallel computing software and numerical libraries in the world
- Developed the slow start algorithm for the Transmission Control Protocol (TCP) part of TCP/IP (Internet Protocol), which enabled the Internet to scale from a small research network to today's worldwide infrastructure
- Implemented ESnet asynchronous transfer mode (ATM), acknowledged by Sprint as accelerating ATM for Internet-wide networking by 5-10 years
- Developed the high performance network interface (HiPPI), now the industry standard for computers and peripherals interconnects



Wave functions for the breakup of a system of three charged particles.

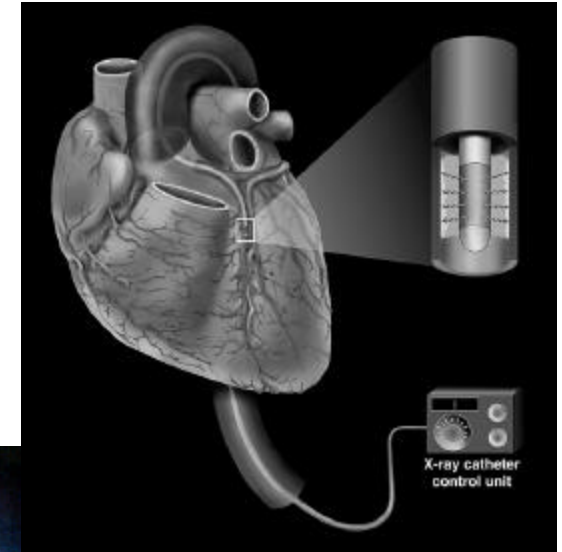
Understanding the Microbial Cell



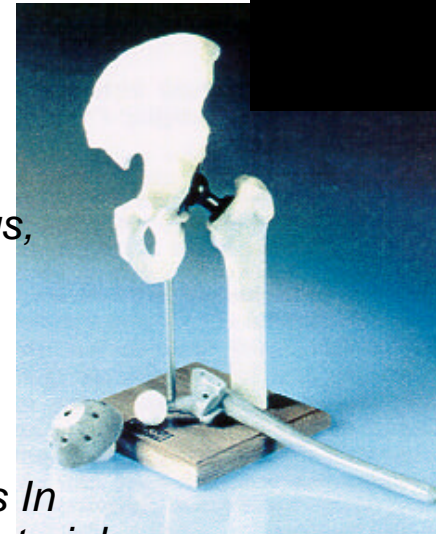
- **Goal:** To understand the complete workings of a microbial cell and to use this information to address DOE needs in energy use and production, bioremediation, and carbon sequestration:
- **Challenges:**
 - *Given the minimum set of genes necessary to sustain a simple free-living microbial cell, express the genes to produce the relevant proteins, and determine their structure.*
 - *Determine the physiological and biochemical functions of the genes and specific bioprocesses using standard biochemical techniques and structural/computational biology.*
 - *Use high-end computing to model gene-gene, gene-protein, and protein-protein interactions as well as the internal biochemistry of the cell.*
 - *Use gene-protein manipulation to enhance or suppress various cell functions.*
 - *Focus on functions that are relevant to DOE goals, e.g., bioremediation, carbon sequestration, sustainable energy production.*

Biomedical Engineering

- **Goal: Foster research using DOE's unique resources in the biological, physical, chemical, engineering, and computing sciences to provide high-risk, engineered solutions to medical needs.**
 - *In FY2001, this activity will support innovative programs including nanomedicine, biomaterials, spectroscopy, and molecular biology to provide the scientific foundation for the development of engineered human tissue, sensitive devices for disease detection, and artificial organs and limbs.*
 - *Member of the Bioengineering Consortium (BECON), a federal working group on biomedical engineering that includes the NIH institutes and NSF. BECON coordinates and fosters new basic understandings, collaborations and transdisciplinary training in bioengineering among the participating agencies.*
 - *Will be coordinated with BECON activities and will utilize the BECON expertise to validate the medical relevance of cutting-edge technological advances in the national labs involving, e.g., biologics, materials, processes, implants, devices, and information systems.*



Tools to prevent blockages from reoccurring following angioplasty



Biomaterials for artificial joints

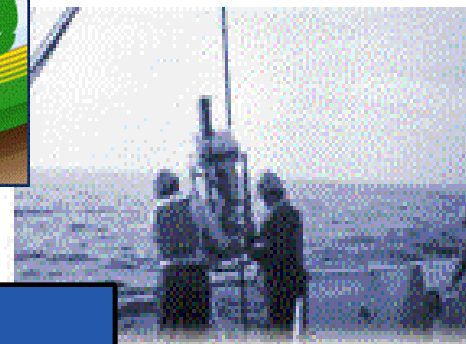
Carbon Management Science

Climate Change Technology Research

- \$36 Million in the Office of Science in FY2001
 - \$16 M in *Biological & Environmental Research*
 - soils and vegetation, oceans, advanced biological sequestration research
 - \$20 M in *Basic Energy Sciences*
 - 52 new projects have been started at national laboratories and universities related to increased energy efficiency and to carbon sequestration in geological formations
- Emphasizes carbon sequestration science; science for efficient technologies; and science to advance low- and no-carbon energy sources
- Coordinated with Offices of Fossil Energy and Energy Efficiency & Renewable Energy

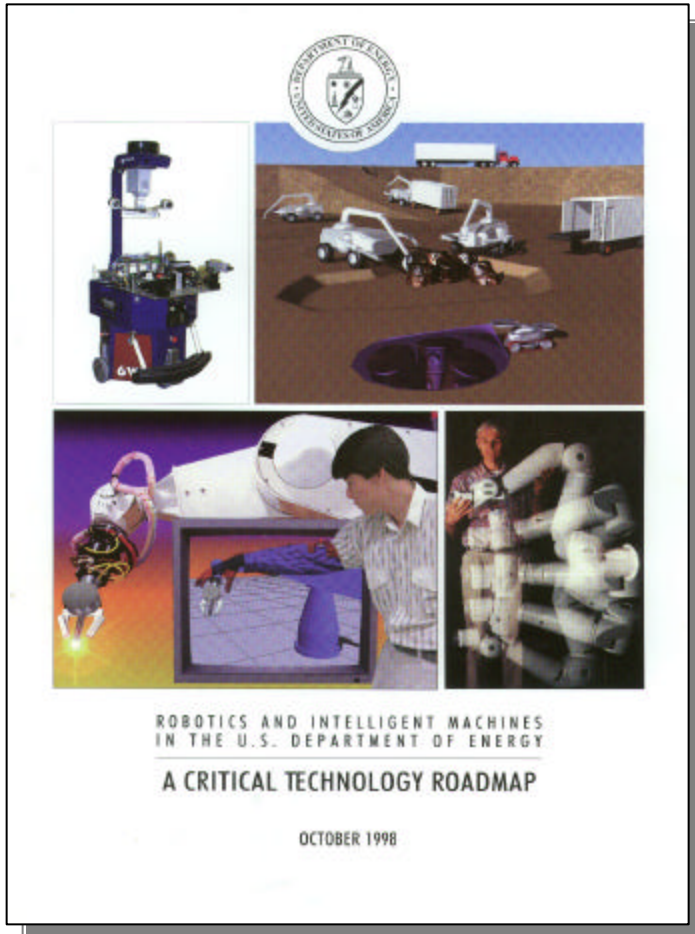


Two new sites for fundamental research on carbon sequestration in the terrestrial ecosystem and in the ocean



Catalysts, such as this metallocene compound, increase efficiency and reduce pollution

Robotics and Intelligent Machines



- University-based research effort focussing on sensors and sensor integration, remote operation, data acquisition, and controls.
- Topics address DOE mission areas including remote access to user facilities.
- Activities follow the Robotics and Intelligent Machines Roadmap
 - *completed in 1998*
 - *participation from*
 - DP, EE, EH, EM, SC, FE, MD, NE and NN
 - representatives of national laboratories
 - representatives from NSF and DARPA
- Part of a coordinated DOE-wide activity

Experimental High Energy & Nuclear Physics *Facilities Poised to Make New Discoveries*

- Fermilab Main Injector completed in FY99 on schedule and within budget. FY 2001 experiments will take advantage of new capabilities at the world's highest energy.
- SLAC B-factory full operation in FY 2000 on schedule and within budget. World record luminosity achieved; full luminosity and significant results on CP violation in B decays expected by summer 2000.



B-factory Dedication

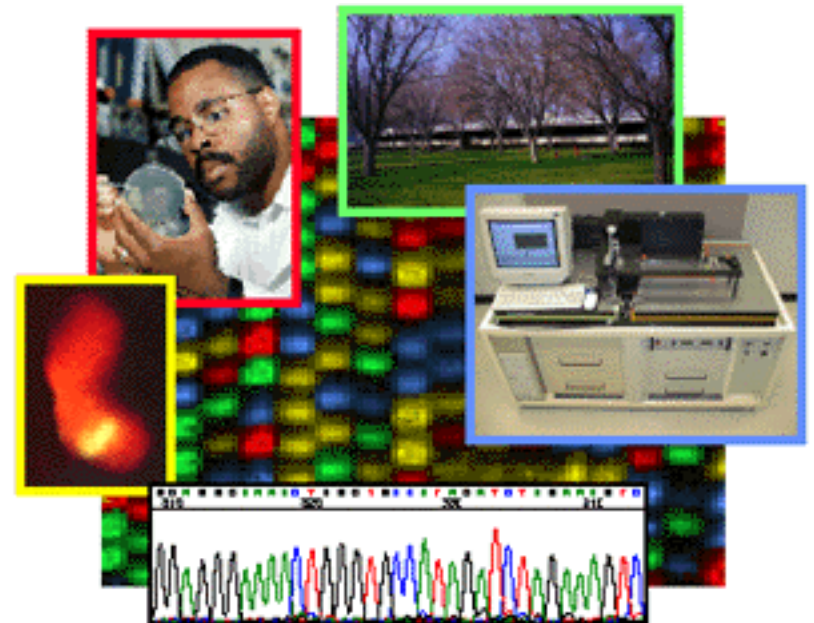


Relativistic Heavy Ion Collider (RHIC) at BNL

- RHIC achieves full operation in FY 2001. Four detectors and 950 researchers have begun the search for a “quark-gluon plasma”.
- CEBAF research program hits full stride. FY 2001 increase in beam energy and polarized beam intensities enables measurements with unprecedented sensitivities.

The DOE Human Genome Program

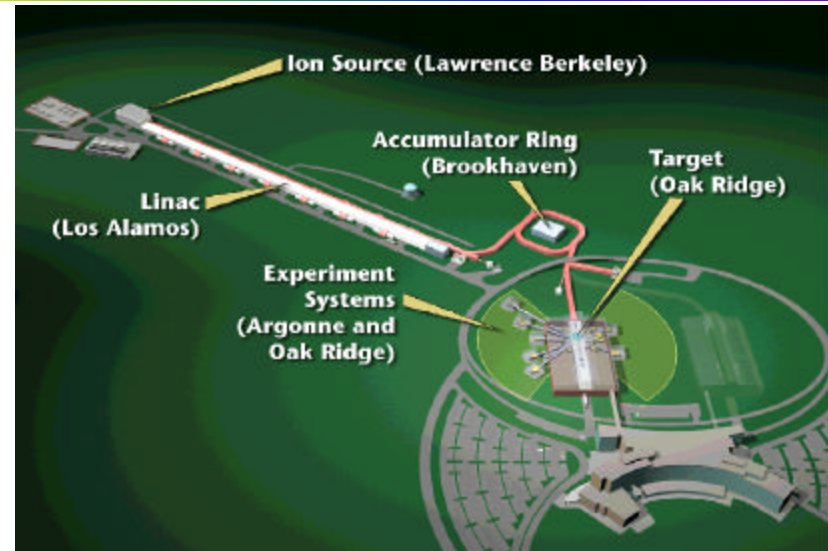
- \$90 Million in FY 2001
- The Joint Genome Institute (JGI) Production Sequencing Factory begins final stage of completing sequence of human chromosomes 5, 16, 19
 - 100 million subunits of finished DNA sequence
 - 250 million subunits of high quality draft sequence
- FY 2000 Accomplishments
 - Draft sequences of human chromosomes 5, 16, 19 completed
 - Entered to public databases
 - 10 mil subunits of finished DNA sequence
 - 70 mil subunits of high quality draft sequence



The Spallation Neutron Source (SNS)

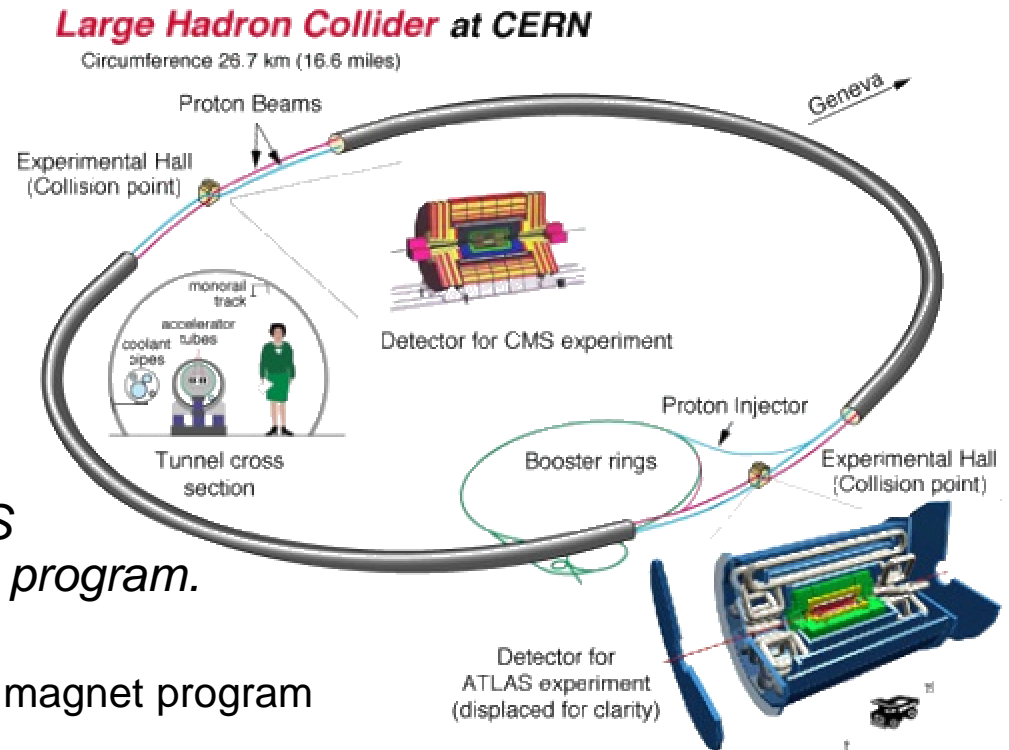
Under Construction on Chestnut Ridge at ORNL

- World's premier neutron scattering facility for basic and applied research in physical, materials, polymer, chemical, and biological sciences
- Unwavering scientific community support; strong multilab commitment; bipartisan Congressional support
- New SNS Project Executive Director, top senior staff, and revised management systems in FY 1999
- FY 2001 activities - Begin Title II design, site preparation, subsystem fabrication, conventional facility construction
- FY 2001 requirement - \$281 million
Project completion - 2006



The Large Hadron Collider (LHC)

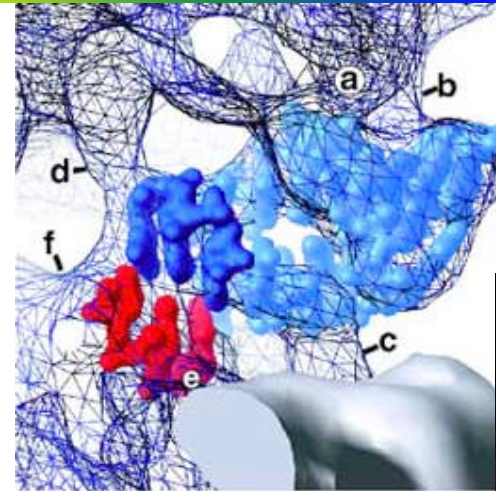
- LHC is the foremost high energy physics facility of the next decade and U.S. participation ensures access for U.S. scientists
- FY 2001 funding is \$70M
- FY 2000 progress:
 - *DOE-NSF agreement in place for U.S. participation in the LHC research program.*
 - *U.S. LHC Accelerator*
 - Interaction Region Quadrupoles model magnet program completed
 - Superconducting Cable Production measurement equipment delivered to CERN
 - *U.S. ATLAS Detector*
 - Fabrication work on the Liquid Argon Calorimeter - barrel cryostat progressing well
 - Production of the Tile Hadronic Calorimeter underway
 - *U.S. CMS Detector*
 - Hadron Calorimeter Design Reviews passed - absorber & scintillator production underway
 - Full-scale production underway on Endcap Muon cathode strip chamber - cathode panels



Scientific Facilities Utilization

Full Productivity of the DOE S&T Infrastructure

- Presidential Initiative - FY 1996;
Renewed commitment - FY 2001
- Used by over 15,000 scientists from universities, industry, and federal laboratories each year
- Facilities are critical to progress in the physical, chemical, engineering, biological, and life sciences
- \$1.21 billion in FY 2001 (*up \$65M from FY00*)
- Full upgrade of SSRL, joint with NIH
- Operations, beamline construction, infrastructure improvements for the facilities
 - ALS, APS, NSLS, SSRL
 - HFIR, IPNS, LANSCE
 - EMSL, CRF II
 - B-Factory, Fermilab Main Injector
 - CEBAF, RHIC



ALS image of overall ribosome - After decades of effort, techniques for crystallizing ribosomes and analyzing their structures have begun to yield rich dividends



High Energy Physics particle collision event simulation



The Advanced Photon Source - ANL